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Eurypterid Beds of Nebraska with Notice of a New Species, "Eurypterus Nebraskaensis"

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BY

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EURYPTERID BEDS OF NEBRASKA, WITH NOTICE OF A NEW SPECIES, EURYPTERUS NEBRASKENSIS

BY ERWIN HINCKLEY BARBOUR

During the field season of 1912, the Nebraska Geological Survey, while pursuing work in the southeastern or Carboniferous corner of the State, with Professor E. F. Schramm in charge of field work, made three discoveries believed to be of interest. These are as follows: three well preserved bony fish; a bed of eurypterids; and a bed of plant tissue, preserved as such from Carboniferous times.

It is the purpose of this paper to consider the bed of eurypterids, to add one more to the known eurypterid localities for the United States, and to name one new form. Credit for the discovery of this bed is due to J. B. Burnett, University of Nebraska, class of 1915.

EURYPTERIDS IN GENERAL

To those who are unfamiliar with the group it may be explained briefly that eurypterids are fossil crustaceans having flared heads, and slim, flat bodies tapering toward the tail and ending usually in a long pointed spine. Their general outline though like that of the common bullhead fish is distinctly scorpioid. When found a century ago, it was described as a fish.

Their precursors were the trilobites and limuloids, and their successors the scorpions and spiders. Their nearest living ally in the crab family is the horseshoe crab, Limulus polyphemus, commonly known as the king crab or horseshoe crab.

To those living near the New England coast certain Crustacea such as the lobster, crab, shrimp, and horseshoe crab, are familiar objects. To those living inland the common crawfish stands as a familiar example of the group.

The average eurypterid is perhaps eight to ten inches long, but the largest of them, such as Pterygotus, attained a length of six or seven feet. They were undoubtedly the rulers of their time as far as the Crustacea are concerned.

AFFINITIES OF EURYPTERIDS

The close relationship of the eurypterids to the arachnids is very apparent. But it may not be equally clear whether they should be classed with the arachnids or with the crustaceans. Some of the best

systematists put them with the arachnids, others with the crustaceans. This means that they are intermediate forms and that they both branched from the same primitive stock, and have preserved certain ancestral characters in common.

They can be classed with the one group or the other with equal propriety, and yet preference seems to be to group them with the crustaceans, chiefly on account of the mode of respiration.

Breathing in the eurypterids, as in the crustaceans, is performed by means of gills or branchiae, which are adapted for getting the necessary oxygen for respiration out of water, while arachnids get it directly from the free air. They are indirectly related to the trilobites and directly related to the limuloids, and to the ancient and modern Limulus. This is shown pictorially in plate 1. The eurypterid family contains four distinct forms, namely: Eurypterus, Pterygotus, Slimonia, and Stylonurus, each of which contains its quota of species.

The limuloids began in the late Devonian and early Carboniferous and their survivors, the well known horseshoe crab, Limulus, still flourishes in great numbers along our Atlantic coast.

GEOLOGICAL DISTRIBUTION

The trilobites, of which about two thousand species have already been described, began with the earliest Paleozoic and ended with it. They flourished to such an extent in the Cambrian as to exceed in numbers all living forms of that period. During Ordovician and Silurian times they were dominant forms, but during the Devonian their decadence was noticeable, and as the Paleozoic closed the race became extinct, and once extinct means forever extinct. They were so reduced in numbers during Carboniferous times, that only one form, Phillipsia, is known in our Pennsylvanian strata.

The eurypterids, of which thirty or forty species are described, flourished in the Silurian, declined noticeably in the Devonian, and flourished again during the Carboniferous. At the close of the Paleozoic they became extinct.

They came into existence much later and are more advanced and specialized than the trilobites.

EXOSKELETONS OF EURYPTERIDS

Representative members of the crab family are encased in shells of chitin so reinforced and hardened by lime salts as to preclude the possibility of growth, save at the moulting period. At this season lobsters, crabs, horseshoe crabs, crawfish, and their kind begin to

absorb lime from their joints and down the middle of the back, making lines of weakness along which the old shell splits, liberating the occupant. There are many successive moults during the life of a crab, so its growth is slow. The old shells constitute the exuviae or casts, which retain the exact form of the crab and are often buried in mud and fine sand and preserved.

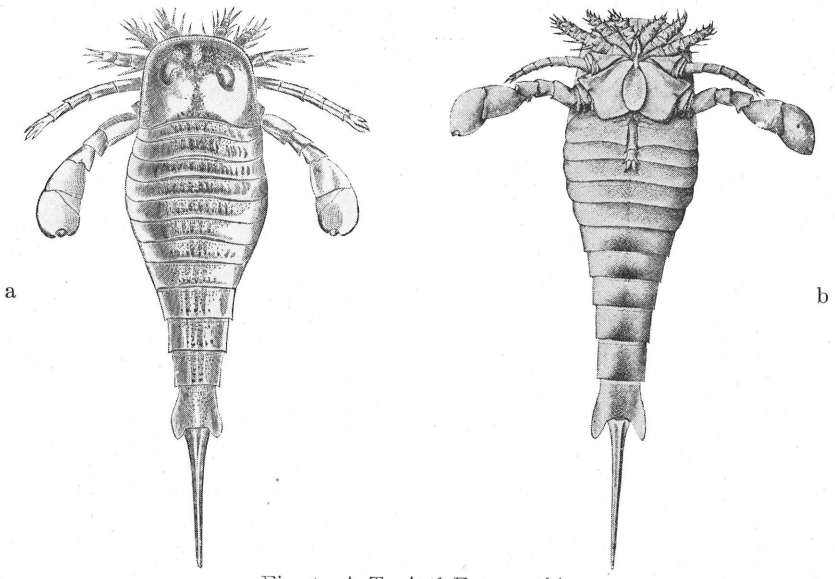


Fig. 1—A Typical Eurypterid.

a, Eurypterus fischeri, dorsal view showing headshield, eyes, and five distinct appendages; 12 abdominal segments; and a pointed spine or telson. The first segment back of the head is No. 7; the last is No. 18; and the spine, if counted, is No. 19. Segments 7 to 19 inclusive constitute the abdomen; 7 to 12 inclusive the preabdomen; and 13 to 19 inclusive the postabdomen. The first visible appendage is No. 2, while the last, the paddle, is No. 6.

b, The same, ventral view. The eliptical area is the metastoma. The median opercular process is just below it. Of the paddles, the quadrilateral patches to the right and left of the metastoma are the coxae.

Such growth as the creature is destined to make must take place immediately following exuviation, while the integument is soft and elastic. This is plainly a danger period in the life of crabs for, being unprotected, they fall an easy prey to enemies. Moulting provides for growth, and for ridding crustaceans, for a time at least, of those

natural impediments, seaweeds, barnacles, shells, worm tubes, and polyps, which fasten upon them to be carried about as commensals or messmates.

The relationship of the eurypterids to the crabs, especially the horseshoe crab, is so close that the life history of the one is virtually that of the other, and it is certain that the eurypterids moulted as do their modern representatives.

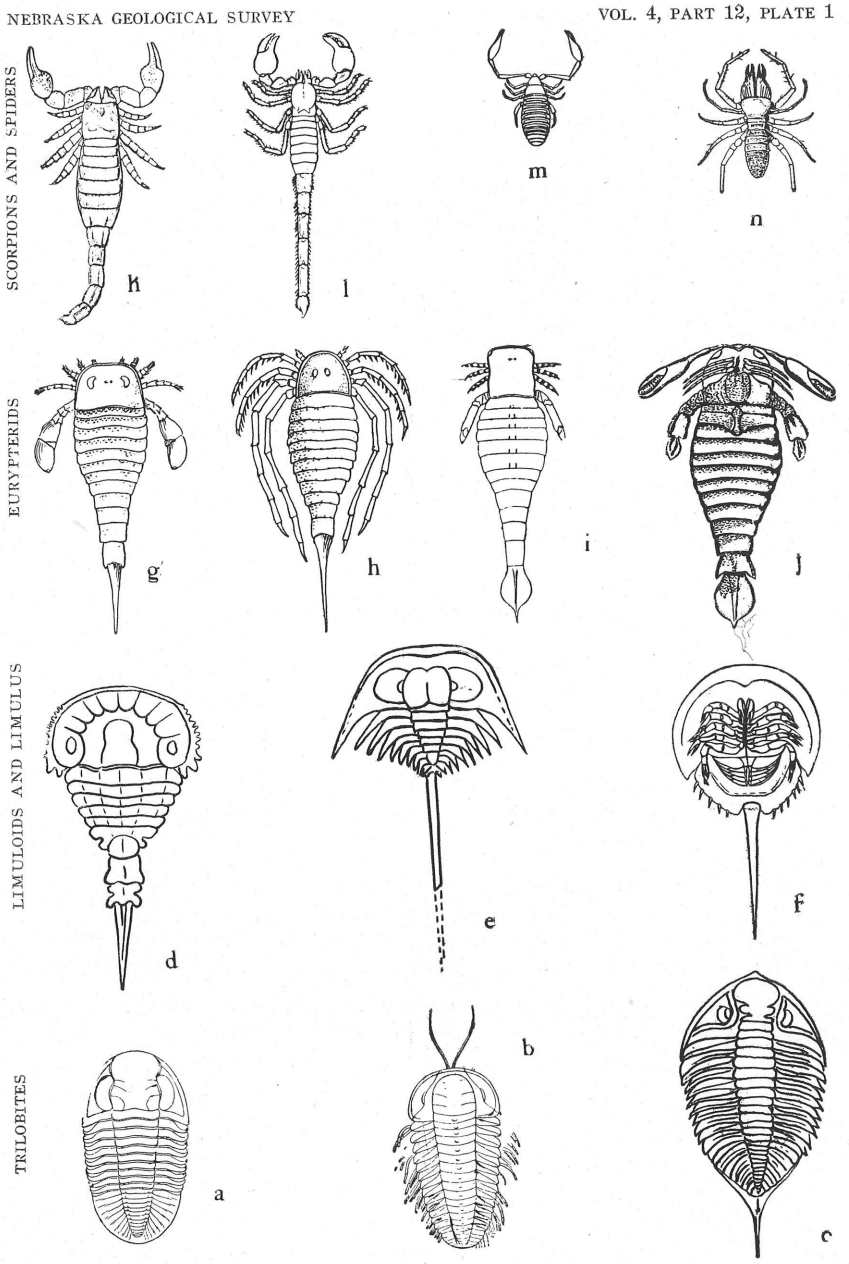
In life eurypterids were encased in a chitinous shell of some substance, and certainly of sufficient rigidity for the attachment of relatively powerful muscles.

In the specimens at hand the shells are flattened and reduced to a carbonaceous film, so attenuate as to pass for mere discoloration. Like crabs, eurypterids made their growth just after exuviation, and attained full size slowly and by successive moults. During the life of an individual eurypterid the shell was cast repeatedly, and it is natural that many of these exuviae should have been buried by mud and thus preserved.

LIFE HABITS OF EURYPTERIDS

Knowledge of the horseshoe crab, Limulus, gives insight into the mode of life of Eurypterus. The name Eurypterus means broad wing, in allusion to the broad paddle. Perhaps after all they were not swimmers of great activity. Their broad paddles are evidence but not proof of active swimming habits. It is quite likely that they preferred to crawl, and that they were grovellers, and even played the part of scavengers. Horseshoe crabs frequent muddy and sandy bottoms, and burrow successfully for marine worms, which form a large part of their food. Eurypterids may be viewed as having the ability to swim well, but having a preference, perhaps, for crawling upon sandy and muddy bottoms. The paddle may have been used quite as effectively in covering the creature with a protective coat of sand as in swimming. In escaping their enemies it seems likely that they resorted to stealth and concealment rather than flight. Like the crabs they probably benefited by protective coloration, and were rendered inconspicuous if not quite invisible to enemies. If frequenters of muddy bottoms, their powerful paddles enabled them to instantly roil the water about them; if of nocturnal habit, they would thereby escape many natural enemies. Undoubtedly the bayonet-like telson could be raised and flourished in a threatening and defensive manner.

Eurypterids breathed by means of gills, which are distinctive badges of the Crustacea, while arachnids, with which they are akin in all



ANCESTRAL CRUSTACEANS AND THEIR SUCCESSORS, SCORPIONS AND SPIDERS

a, Phillipsia. b, Triarthrus. c, Dalmanites. d, Hemiaspis. e, Belinurus. f, Limulus. g, Eurypterus. h, Stylonurus. i, Slimonia. j, Pterygotus. k, Palaeophonus, fossil scorpion. l, Scorpio, modern scorpion. m, Chelifer, false scorpion. n, Datames, a spider.

essentials, are modified for breathing free air. This difference is one of the reasons for associating eurypterids with the Crustacea rather than with the Arachnida.

GROSS ANATOMY OF EURYPTERIDS

Their prominent features are: a large, flat head, two broad paddles, and a segmented body tapering toward the tail and ending in a long spine.

The headshield or carapace, commonly semicircular, but sometimes more or less quadrate, bears two conspicuous compound eyes as well as certain simple eyes, called ocelli, which are generally quite obscure. It is not unlikely that the shape of the head enabled the eurypterid to root or shovel and burrow like the horseshoe crab.

On the under side of the headshield is the mouth, centrally located, and surrounded by six pairs of appendages variously modified to serve one or more useful purposes. Of these, pair No. 1 is in front of the mouth, preoral, while pairs 2, 3, 4, 5, 6 are back of the mouth, or postoral.

The first pair of appendages, the chelicerae, are preoral, and were presumably innervated from the supra-oesophageal ganglion, are sensory and antennal in function, and are armed in most cases with inconspicuous nippers, chelae. The chelicerae of Eurypterus are very small, but in Pterygotus they are large, almost the size of a man's hand.

The five succeeding pairs of appendages, which were presumably innervated from the ventral chain of ganglia, are all modified for locomotion. Since the mouth is jawless the bases of the surrounding pairs of appendages are serrated, spined, and dentated to serve as jaws, and are called maxillipedes or jaw-feet. This may seem to be a primitive type of masticatory device, yet it served the purposes of grasping, and of rough mastication.

The fifth pair is modified to brace against sand and mud, and the sixth pair for swimming, and perhaps for roiling the water for concealment and escape.

The resemblance of average eurypterids to scorpions is very striking, especially so in the case of Eusarcus, which has a curved telson resembling the sting of the scorpions. In the case of scorpions the spine is converted into a curved sting which injects a painful though not fatal poison into intruders. This serves for defense and for stunning prey. After seizing its prey the scorpion holds it in its strong claws,

and throwing its tail forward over its back stings the victim to death. One is led to wonder if some of the sea scorpions, the eurypterids, may not have used their sharp spines in a like manner.

For the purpose of this paper it matters little whether the carapace of eurypterids extends over the head alone or over the head and thorax.

We shall view the headshield, with its six pairs of appendages, as constituting the cephalothorax. This consists morphologically, though not visibly, of six coalesced segments, each corresponding to a pair of appendages. Back of the headshield, comes a portion made up of free articulated segments. This is known as the abdomen, and consists of thirteen segments, providing the telson, which in fact may be an appendage, is included. Adding the six morphological segments of the carapace to the thirteen of the abdomen, makes a total of nineteen, which are numbered as follows: The first segment back of the headshield is numbered 7, the second 8 and so on to the telson which, if included, is No. 19. The segmented abdomen shows two distinct regions, a body, and a tail portion. The six anterior segments, namely numbers 7, 8, 9, 10, 11, 12, constitute the body, or preabdomen. These segments bear on the ventral surface certain gill plates homologous no doubt to the branchial plates of the common horseshoe crab. It may be explained that it is through these branchiae, or gills, that respiration is accomplished.

Segments 13, 14, 15, 16, 17, 18, are without appendages and are annular. The diameter or each succeeding ring grows narrower but longer towards the telson.

NEBRASKA EURYPTERID BEDS

Our eurypterid bed occurs in a bluff of Pennsylvanian limestone bordering the Missouri River, one mile south of Peru, Nemaha County, Nebraska.

Along the Missouri River front, from Omaha southward, the Pennsylvanian bluffs generally consist of alternating beds of limestone and shale, which occasionally merge into local beds of sand. At Peru, the bluffs consist of alternating layers of limestone and shale, but just south of town, the shale layers are observed to thicken gradually until the stone layers are pinched out altogether, and shale predominates. Southward, this shale, some forty to fifty feet in thickness, begins to grow increasingly arenaceous, until it grades insensibly into cross-bedded sand. This order is symmetrically reversed a mile beyond.

Formerly this bluff was a deflection bank of the Missouri, but the main current has shifted about three-quarters of a mile to the eastward, leaving an extensive willow-covered sand bar between the bluff and the river, and now the tracks of the Burlington skirt the base of the cliff.

About ten feet above the tracks of this road, and about thirty feet above the river level, there occurs in this sand a local shaly layer, perhaps three hundred feet long, and scarcely a foot thick, composed of thin shale seams alternating with micaceous sand. The topmost part of this layer bears the eurypterids. The shale seams are seldom a full half inch in thickness, and cleave rather readily. Because of shrinkage joints, the eurypterid shale tends to break irregularly into rather small pieces, thus damaging or destroying many a good specimen. Since the removal of an overhanging ledge, the work of collecting is rendered less difficult and dangerous. Between thirty and forty specimens have now been secured on less than forty square feet of shale, or approximately one to the square foot.

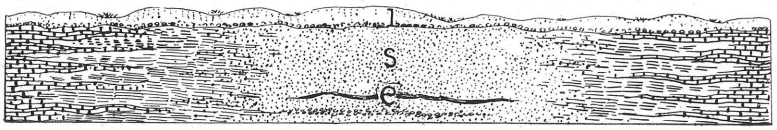


Fig. 2. Section a mile in length, about 1 mile south of Peru, Nebraska.
1, Loess underlaid by drift.
s, Sand grading into shale and then to limestone.
e, Eurypterid shales.
The coarse conglomerate below e contains fossil logs and limbs.

As to the state of preservation, some specimens are faint, while others are bold and distinct, and so colored as to be well differentiated from the slate-colored background. Occasional specimens are perfect, to the extent at least that the gross anatomy may be worked out with considerable nicety and detail, even to the sculpturing and ornamentation. In point of size they are miniatures, providing adult forms are represented.

The average length of these eurypterids is two and one-half inches. The largest individual found as yet is less than three inches long. Undoubtedly these Nebraska eurypterids are directly related to those of the Coal Measures of Illinois, described by Meek and Worthen, and named Anthraconectes.

While the eurypterid beds of New York surpass all others in the variety of forms and excellence of preservation, yet the Nebraska

beds promise to make an unusual showing numerically. It is quite probable, of course, that many of the specimens from Peru are casts or exuviae, and there seems to be no ready means of distinguishing.

ASSOCIATED PLANTS

Associated with the eurypterids at Peru are innumerable leaves, stems, and fragments of land plants, particularly the pinnules of Neuropteris, the stems of Calamites, and whirls supposedly of Sphenophyllum or Asterophyllites. The last mentioned add greatly to

Fig. 3. Eurypterus nebraskensis, sp. nov.
a, Obverse, from which Fig. 4 was sketched.
b, Reverse, showing associated Neuropteris and Asterophyllites.
Both figures natural size.

the beauty of the specimens obtained because of their close resemblance to pressed flowers, for which they are often mistaken. There were also considerable amounts of actual plant tissue, preserved as such from Carboniferous times. It is of a bright clear yellow color, and has sufficient substance and pliability to be stripped from the shale, floated on glass slips, and permanently mounted. Our collection con-

STUDENTS AT WORK IN THE EURYPTERID BEDS AT PERU, NEBRASKA.

Loess and soil 50 feet. e, Eurypterid beds. d, Glacial drift. c, Conglomerate with petrified logs and limbs. Valley of the Missouri River to the left.

tains one hundred of these mounts, which will be studied, photomicrographed, and reported upon in another article. This association of eurypterids with land plants has been noted before, and suggests the probability that Eurypterus had undergone modification suiting it to brackish or fresh water conditions. It is believed that Eurypterus was of marine habit, and that Anthraconectes had a brackish or fresh water adaptation.

EURYPTERUS NEBRASKENSIS, SP. NOV.

The main features of Eurypterus nebraskensis are the vermiform appearance, especially in the smaller examples; the long slim spatulate paddles, and the spinous ridges upon the last five tergites of the postabdomen.

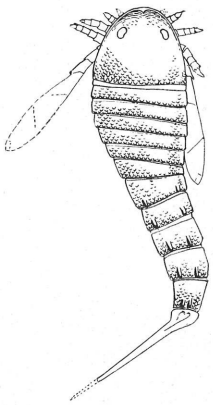


Fig. 4. Eurypterus (Anthraconectes) nebraskensis, sp. nov. Dorsal view. Natural size.

Collection of Hon. Charles H. Morrill, The State Museum.

As compared with well-known eurypterids, those of Nebraska are small, the average being a trifle over two inches in length, while the largest do not equal three inches. In Eurypterus nebraskensis the preabdomen is but slightly inflated, and blends gradually into the postabdomen, giving a vermiform appearance. The telson is uncommonly long and slender. The scale markings are distinct, and very regular in pattern over the tergites. They are semilunar and the effect is that of imbricated scales of fishes. The scale markings continue upon the base of the cephalothorax, but in decreasing numbers anteriorly. At the genal angles, the scale markings are smaller and closely crowded together. The preabdomen is widest at the second and third somites, and tapers gradually to the telson. In none of the somites are the

pleura produced into sharp angles or spines as far as can be observed. The eyes are roundish reniform in shape, are well apart, and close to the borders. Ocelli are not discoverable. The front of the cephalothorax is ornamented by fine closely crowded concentric lines, which curve forward and outward from the median line and meet the cephalic rim.

Measurements of Eurypterus nebraskensis:

The carapace is 9.5 mm. long by 11 mm. wide at its base. The preabdomen is 9 mm. long by 12 mm. wide at somites 9, its widest point. Somite No. 1 is .5 mm. long by 11 mm. wide. No. 2 is 1.5 mm. long by 12 mm. wide.

Each of the others approximate 1.75 mm. In the postabdomen, segment No. 13 measures 2.5 mm. long by 8 mm. wide. No. 18 is 5 mm. long by 3 mm. wide. The accompanying figure of Eurypterus nebraskensis is drawn to exact size.

EURYPTERUS, SP.

This form, possibly a different species, has a noticeably inflated body; long narrow paddles; and pleura seemingly produced into spines. See Fig. 5.

Fig. 5. Eurypterus (Anthraconectes), sp. Ventral view showing large eliptical metastoma, and median opercular process. Natural size.

Segments 11, 12, 13 are short, possibly because telescoped, which may account also for the expanded body. At any rate this specimen was the only one of the kind found. The specimen is pressed as flat as paper, and it seems to be the ventral surface which is exposed.

The eliptical portion of the head, which is unmistakably defined, is taken to be the metastoma, and yet it is altogether too large. It extends

well across the headshield. The median opercular process, assuming it to be such, is broad and well defined proximally, and is fairly distinct along one border. Segment 1 of the paddles seems plain, while 2 and 3 are reasonably so.

The specimen is small and colored like its background. Accordingly blemishes and irregularities are not always distinguishable from articulations. The greatest width of the preabdomen is between segments 10 and 11. The accompanying outline drawing is natural size.

In the case of figures 4 and 5 the outlines were obtained by tracing around enlarged photographs, and are thought to be reasonably accurate.

This set of eurypterids is a part of the varied geological collection of Hon. Charles H. Morrill, in the State Museum, the University of Nebraska.

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